

REMARKS

In view of the preceding amendments and the comments which follow, and pursuant to 37 C.F.R. § 1.111, amendment and reconsideration of the Official Action of October 21, 2003 is respectfully requested by Applicant.

Summary

Claims 1 – 16 stand rejected. Claims 1 – 16 remain pending following entry of the present amendments and remarks.

Rejection under 35 U.S.C. § 103

The Examiner has rejected claims 1, 2, 7, and 13 - 16 under 35 U.S.C. § 103 (a) as being unpatentable over US Patent Publication 2002/0034055 to Seyama et al in view of Mack et al. (US 6,462,919) and in further view of Tornø et al. (US 6,447,689). The pending claim 1 relates to a magnetic sensing element which comprises a laminate. The laminate includes a first antiferromagnetic layer, a pinned magnetic layer, a nonmagnetic conductive layer, a free magnetic layer, a nonmagnetic interlayer, a ferromagnetic layer, and a second antiferromagnetic layer, which magnetically couples with the ferromagnetic layer to orient a magnetization of the ferromagnetic layer in a predetermined direction. Further, claim 1 recites that "the laminate has a recess extending through the second antiferromagnetic layer and the ferromagnetic layer, a bottom face of the recess lying in the nonmagnetic interlayer, a width of the bottom face in a track width direction being equal to a track width."

Thus, as claimed the nonmagnetic interlayer is only partly removed to have the bottom face of the laminate recess be located in the nonmagnetic interlayer, which is, as stated above, sequentially layered on top of the free layer. Applicants submit that this structure of the magnetic sensing element is not taught or suggested by any of the references cited, and that no motivation

for combining the teachings of Seyama and Mack with that of Torng may be established.

Seyama does not teach or suggest a recess which extends through the second antiferromagnetic layer and the ferromagnetic layer in which the bottom face of the recess lies in the nonmagnetic interlayer. Further, in Mack the bottom face of a recess lies directly on the top of free layers 208 and 232, see Figures 6A and 6B respectively. The structure of the laminate provides the nonmagnetic interlayer 16 to function as a protective layer for the free magnetic layer 15 in the region corresponding to the track width T_w . In addition, by forming a nonmagnetic interlayer 16 using a conductive material, the nonmagnetic interlayer 16 can further function as back layer exhibiting a spin filter effect (See page 51, line 27 to page 52, line 5). Typically, a giant magnetoresistance (GMR) effect is mainly caused by a "spin-dependent scattering" of electrons. That is, the GMR effect is obtained using the difference between the mean free path λ^+ of the conduction electrons having a spin parallel to the magnetization direction of a magnetic material, i.e., a free magnetic layer (for example, spin-up electrons) and the mean free path λ^- of the conduction electrons having a spin antiparallel to the magnetization direction (for example, spin-down electrons).

Further, when a back layer is provided, the spin-up electrons which have passed through a free magnetic layer are transported through the back layer by an additional mean free path determined by the material of the back layer, and then scattered. That is, by providing the back layer, the mean free path of the spin-up electrons is extended by the additional mean free path length (See page 54, line 21 to page 55, line 1). As such, since the nonmagnetic interlayer 16, shown in Fig. 1, functions as a back layer, the mean free path of spin-up conduction electrons can be extended. Therefore, a change in the mean free path of spin-up electrons due to an applied external magnetic field is increased, thus improving the rate of the change in resistance ($\Delta R/R$) in the spin-valve magnetic sensing element (See page 55, lines 2 – 7). Hence, the magnetic

sensing element has improved sensitivity to magnetic fields, such as magnetic fields related to stored data. Therefore, the additional sensitivity of the magnetic sensing element due to the laminate recess having a bottom face in the nonmagnetic layer is not disclosed or suggested by Mack.

Further, the Examiner states that in the magnetoresistive device of Seyama in view of Mack the bottom face lies on the free magnetic layer rather than on a magnetic interlayer, but that Torng teaches a magnetoresistive sensor with a recess in which a bottom face lies on a nonmagnetic layer, namely a seed layer 12. However, Applicants would respectfully disagree and would point that although the seed layer 12 is non-magnetic; the seed layer 12 differs in function, and placement to Applicants recited non-magnetic interlayer 16. Torng states that "The key elements of a spin valve structure are, in addition to a seed layer and a cap layer, two magnetic layers separated by a non-magnetic layer. The thickness of the non magnetic layer is chosen so that the magnetic layers are sufficiently far apart for exchange effects to be negligible (the layers do not influence each other's magnetic behavior at the atomic level) but are close enough to be within the mean free path of conduction electrons in the material." (See Column 1, lines 53 – 60). Thus, Applicants submit that the non-magnetic layer 16 would more appropriately be analogous in function to Torng 's non-magnetic layer separating the magnetic layers rather than to the seed layer 12. Therefore, Torng teaches a recess that only extends through the leads layer 13' with a corresponding bottom face of the recess lying on the seed layer 12, but does not teach or suggest a recess extending through the second antiferromagnetic layer and the ferromagnetic layer, with a bottom face of the recess lying in the nonmagnetic interlayer which lies on the top of a free magnetic layer.

In addition, Torng states that "The process of the first embodiment of the present invention essentially ends when the structure of FIG. 6 has been achieved. In practice, of course, processing would continue with the formation of a spin valve structure on the exposed seed layer in order to form the structure that was shown in FIG. 1", (See Column 4, lines 33 – 38). Thus, in

Turning the recess ends before the spin valve structure starts in contrast to Applicants recited recess which extends into the claimed magnetic sensing element to lie in the nonmagnetic layer.

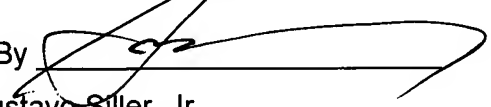
As such, Claim 1 is therefore not rendered unpatentable by the Examiner cited references, either taken alone or if combined. Claims 2 - 16 are each dependent on claim 1, either directly or indirectly, and are therefore likewise patentable. Applicants therefore respectfully request that the rejections of claims 1 - 16 under 35 U.S.C. § 103(a) be withdrawn.

Conclusion

Applicants submit that this application is now in condition for allowance, and favorable reconsideration of this application in view of the above amendments and remarks is respectfully requested. Allowance of claims 1 - 16 at an early date is earnestly solicited. If, there are additional fees due, Applicant requests that this paper constitutes any necessary petition and authorizes the Commissioner to charge any underpayment, or credit any overpayment, to Deposit Account No. 23-1925.

If the examiner finds that there are any outstanding issues which may be resolved by a telephone interview, the Examiner is invited to contact the undersigned attorney at the below listed number

Respectfully submitted,
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